CDF Status and Tevatron Physics Results (II)

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FRA Review

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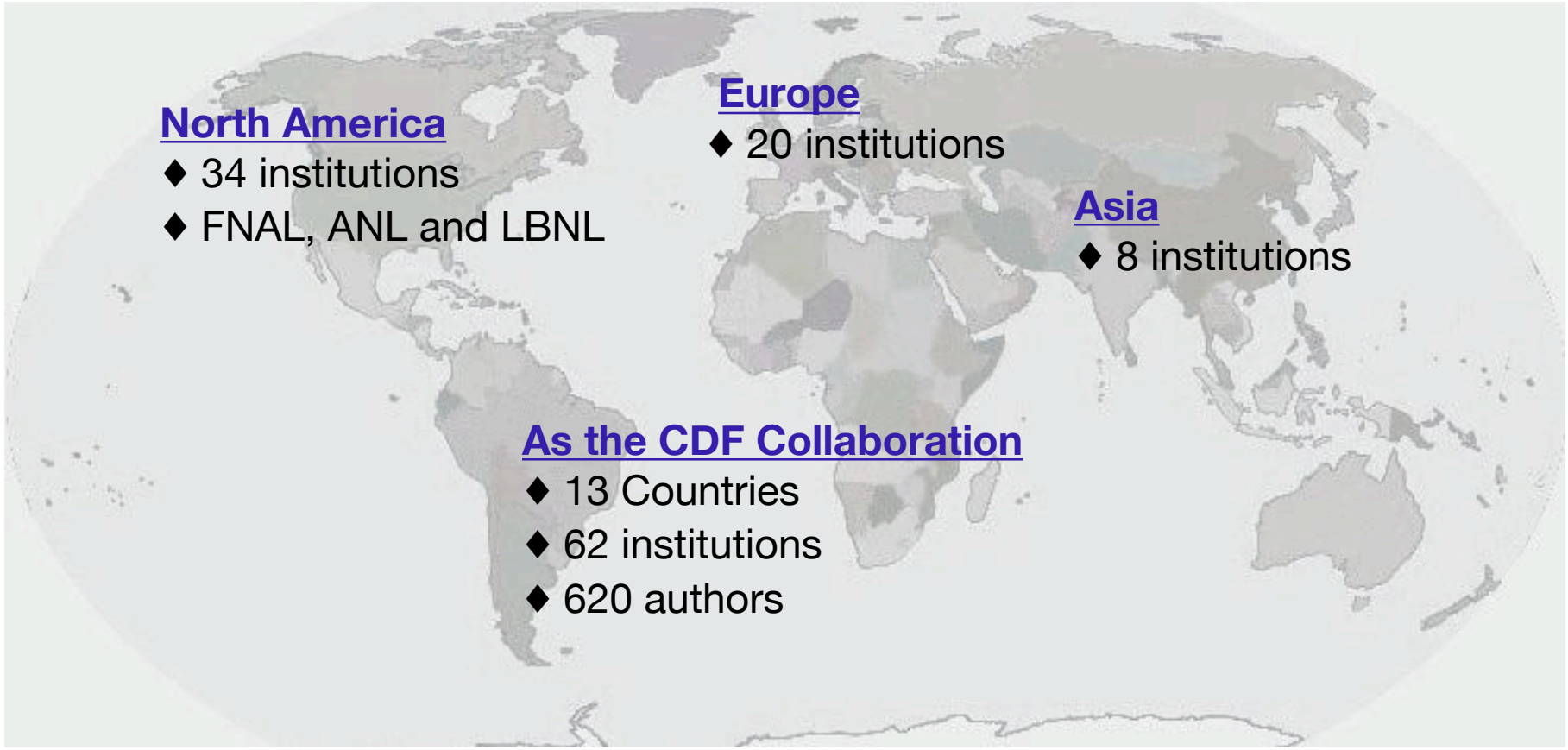
Outline

- CDF perspective
  - Detector operations
  - High luminosity running
  - Data processing
  - People resources
  - Publications
- CDF and D0 physics highlights and prospects - Part II
  - Diboson
  - Top quark properties
  - Top quark mass
  - W boson mass
  - W boson width
  - Standard model Higgs
- Conclusions

Collaboration

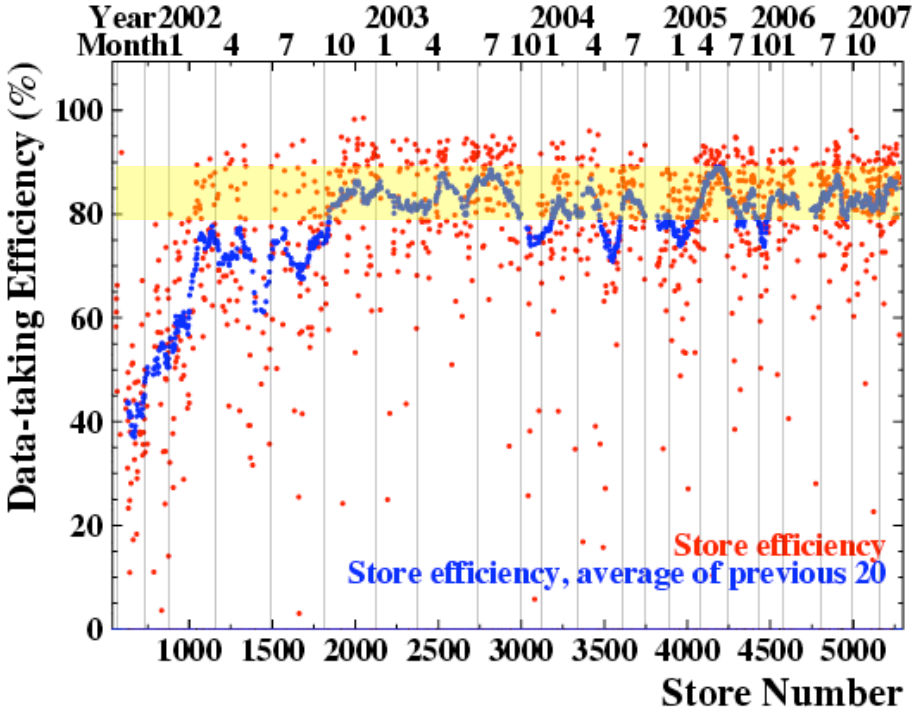


- Fermilab group: ~60 authors including 3 Wilson Fellows, 10 postdocs

Operations and performance

Total luminosity:

~2.7 fb^{-1} delivered, ~2.2 fb^{-1} to tape



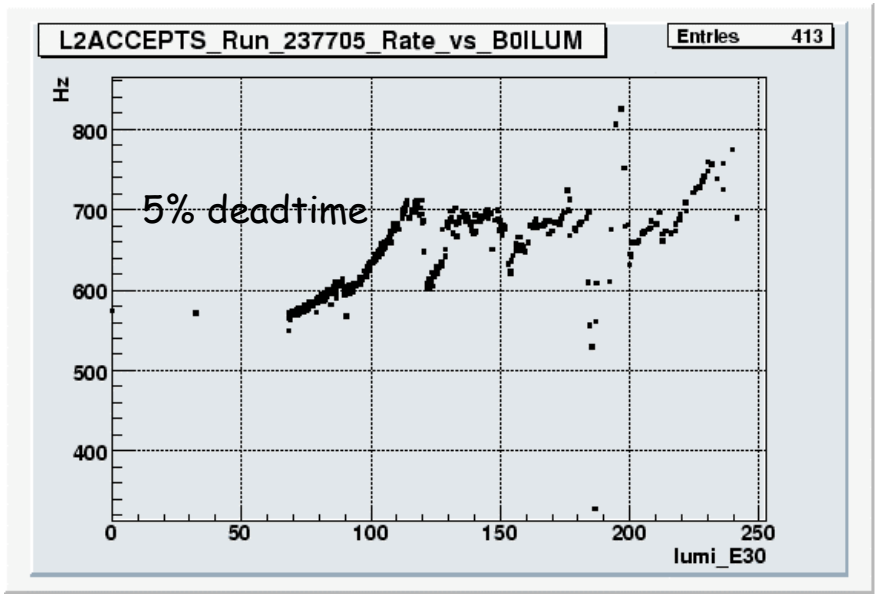
- Stable collection of data: taking efficiency 85% (2003-present)
- Silicon lifetime not expected to be a problem
- Central Tracker aging fixed in 2004 with addition of oxygen
- Trigger and Data Acquisition system evolving with luminosity

	2003		2007
Level 1 trigger:	12KHz	⇒	35KHz
Level 2 trigger:	300Hz	⇒	800Hz
Level 3 trigger:	24MB/s	⇒	100MB/s

Dataset has doubled each of the last 4 years

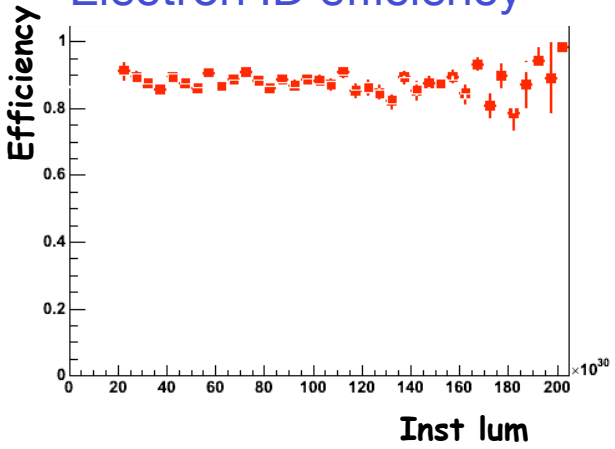
Trigger at high luminosities

- Bulk of [high-p_T] triggers (e.g. Higgs) are fully functional to at least 300e30
  - Identified a few triggers with unacceptable rates
    - Upgrades will help to deal with these
      - CAL upgrade L2 cluster finder for better MET resolution
      - XFT upgrade L2 reduce rate for high p_T muons
  - Using "dynamic prescaling" to optimize physics and bandwidth
    - High rate triggers have large prescale at high luminosity
    - Prescales relaxed as bandwidth becomes available at low luminosity
  - Most of the time is spent at below ~150e30

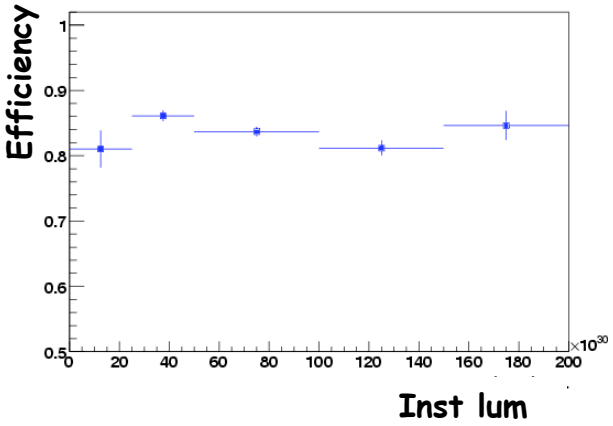


Physics at high luminosities

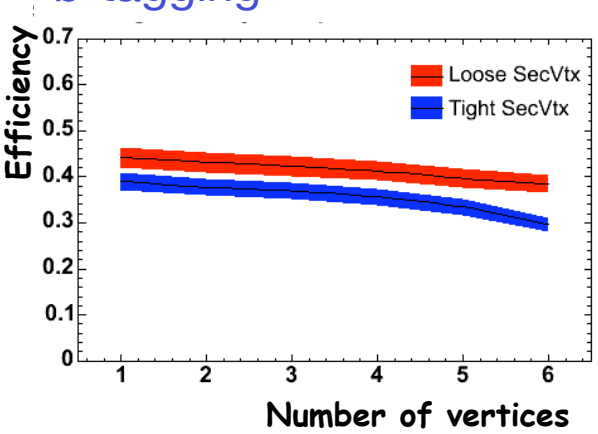
Electron ID efficiency



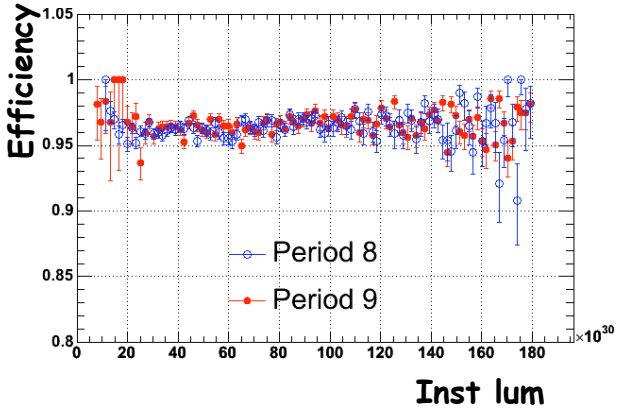
Muon ID efficiency



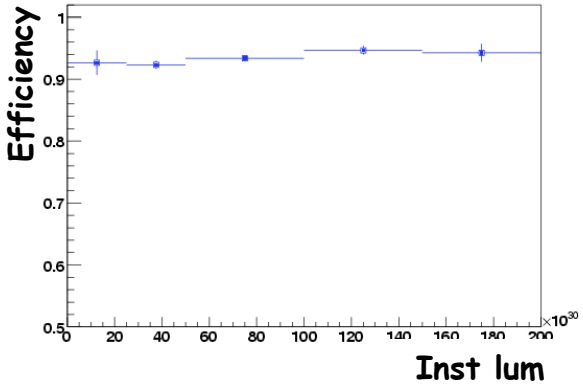
b-tagging



Electron L1 trigger eff.



Muon L1 trigger eff.



- Maintaining excellent performance at all luminosities

Computing

- Resources:
  - 1 THz CPU @ Fermilab for data processing (FARM)
  - 8 THz CPU @ Fermilab for user analysis and Monte Carlo generation
  - 2.5 THz CPU off-site for Monte Carlo generation
  - Also exploits GRID

- FARM can process 25M events per day
  - We log 4-5 M events per day

- CDF uses a one pass data processing scheme
  - Data processed every 6-8 weeks
  - Use final calibration, alignment, reconstruction
  - Publication ready data available up to February 2007 (~2 fb^{-1})

- Data validation and analysis ntuples follow FARMs by 4-6 weeks

Human resources available

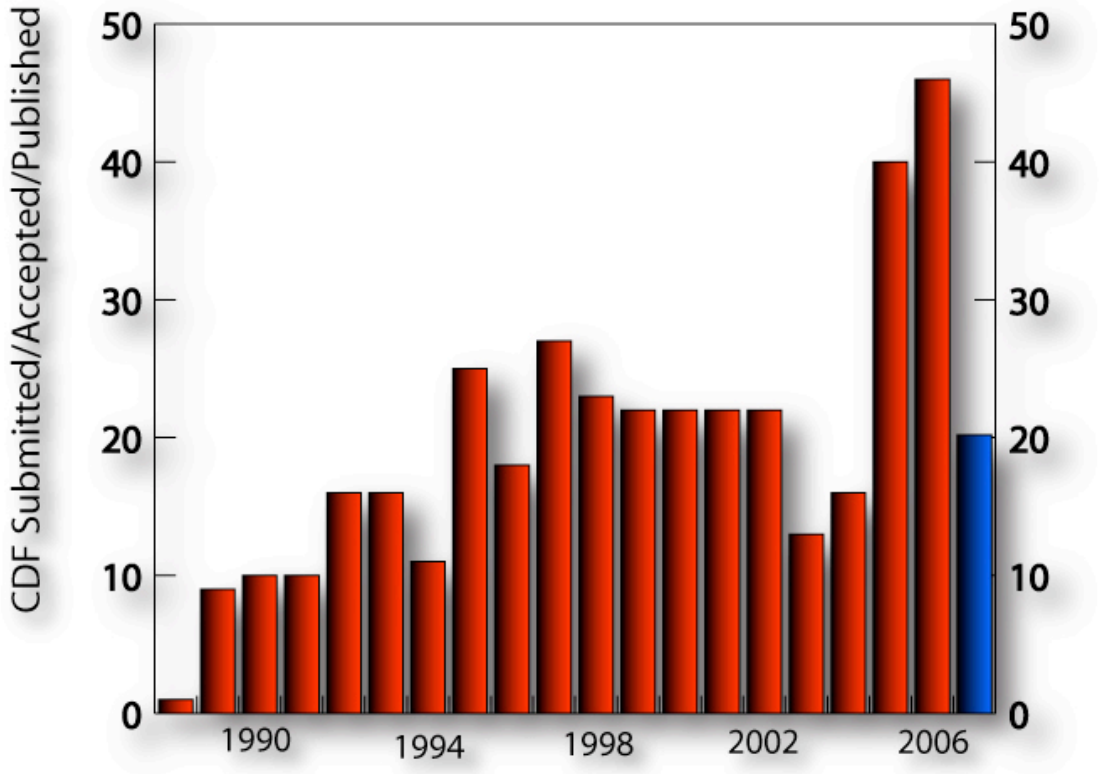
	CY 2007	2009
Total for Operations	124	102
Resources Available	392	236
FTE for Physics	392 - 124 = 268	134
Post Doc's	101	53
Students	147	77

Operations include: detector, offline, algorithms, management

- Collaboration members available in units of FTE
- Expect healthy physics program through 2009
- ~30% more FTE in CY07 than estimated in CY05 !
  - Delay in LHC turn-on
  - Tevatron and CDF experiment running very well
  - Physics and leadership opportunities at CDF

Publications

- Publications submitted+accepted+published
  - 135 Run II publications
  - We also have >50 additional papers under internal review !
  - On track for 40+ publications in 2007



- More than 100 ongoing PhD theses

WZ observation/ZZ evidence

- Summer 2006, $\int L\,dt$ = ~0.8 pb^{-1}

  D0: Observe 12 events with expected background of 3.6±0.2 and signal of 7.5±1.2

  WZ evidence: 3.3 σ significance, $\sigma = 4.0^{+1.9}_{-1.5}$ (stat+syst) pb

  CDF σ < 6.34 pb (95% C.L.)

- Fall 2006, $\int L\,dt$ = 1.1 pb^{-1}

  CDF: improved lepton identification (x2), added triggers (~10%), added data (30-40%)

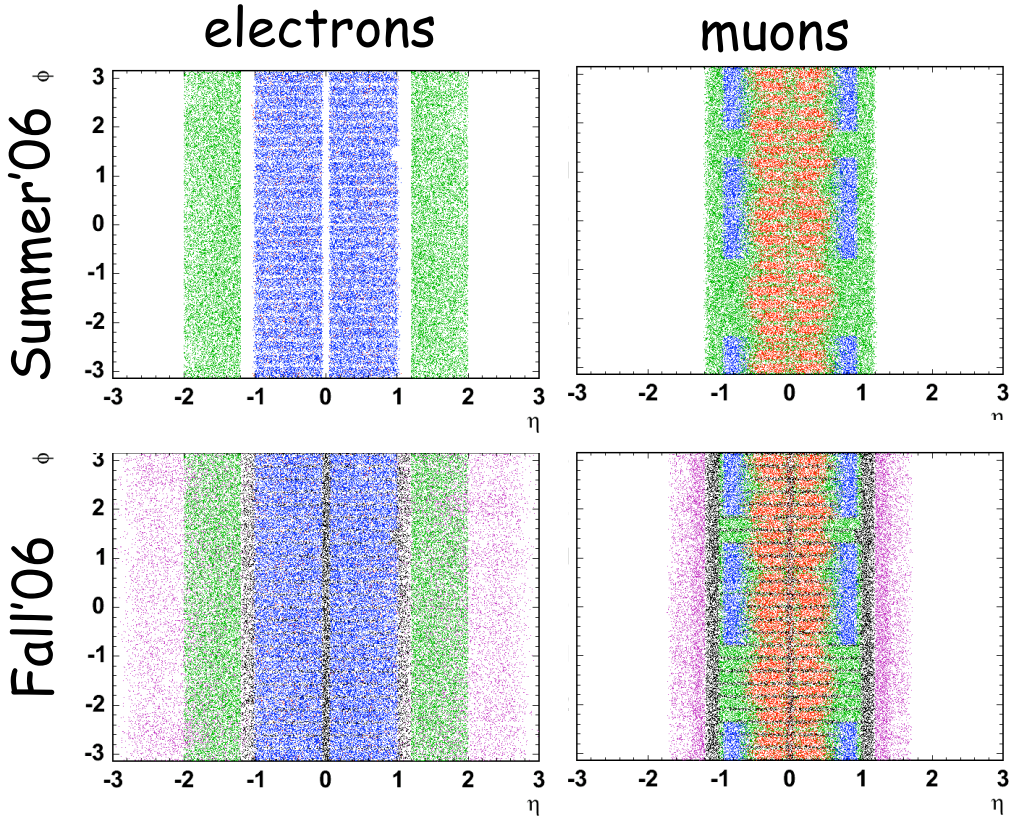
  WZ observation: 6 σ sig.,

  $\sigma = 5.0^{+1.8}_{-1.6}$ (stat+syst) pb

- Winter 2007, $\int L\,dt$ = 1.1 pb^{-1}

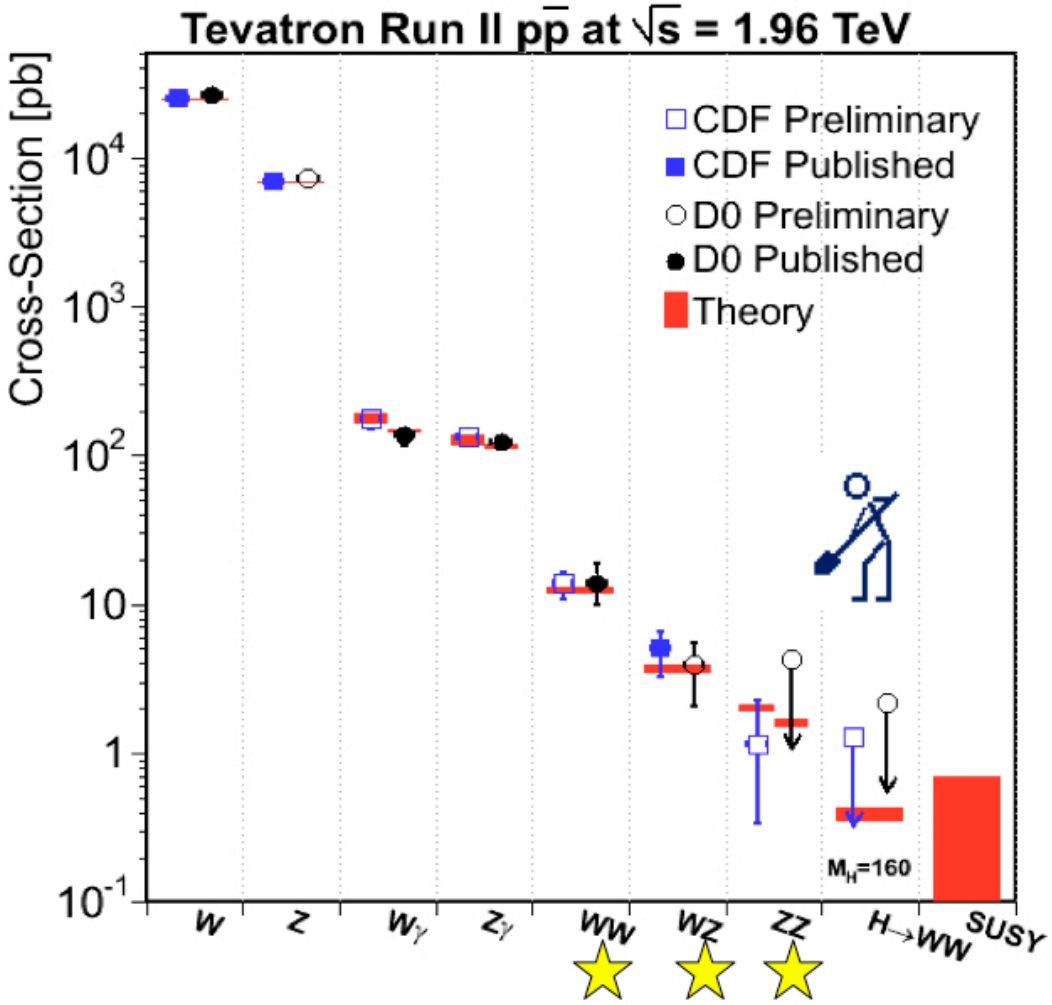
  ZZ evidence: 3 σ sig.,

  $\sigma = 1.14^{+1.1}_{-0.8}$ (stat+syst) pb



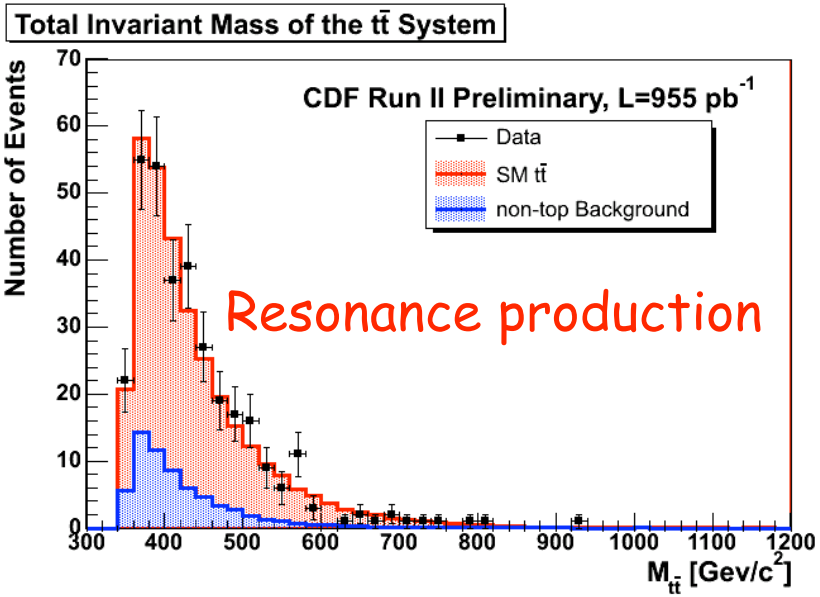
Moving towards smaller cross-sections

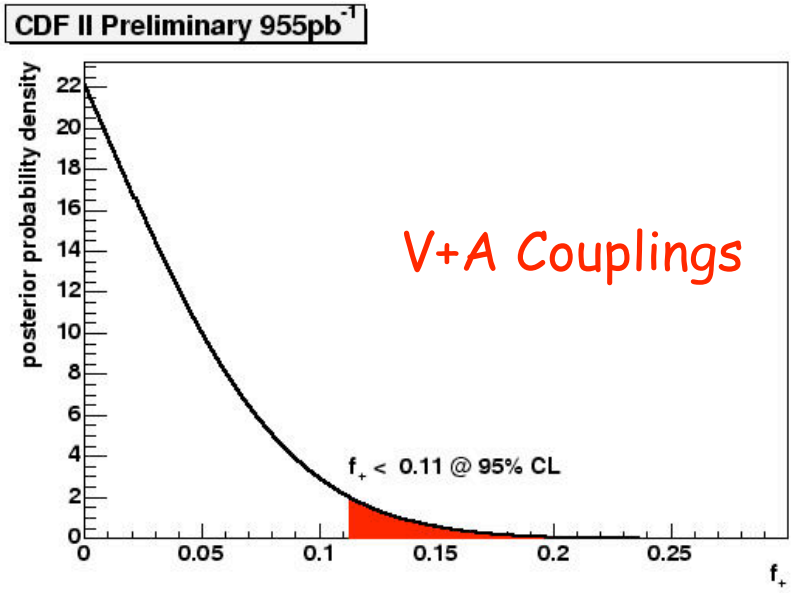
- Given enough time (data) we can get there

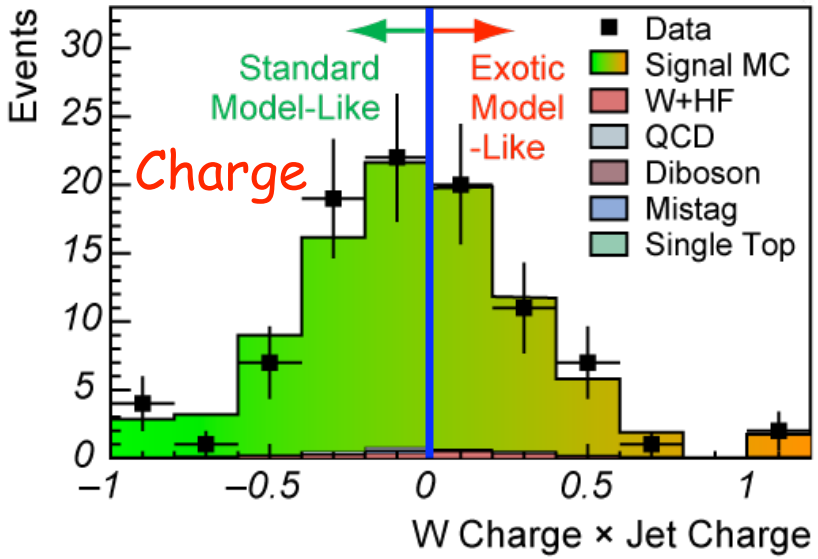


Top quark properties

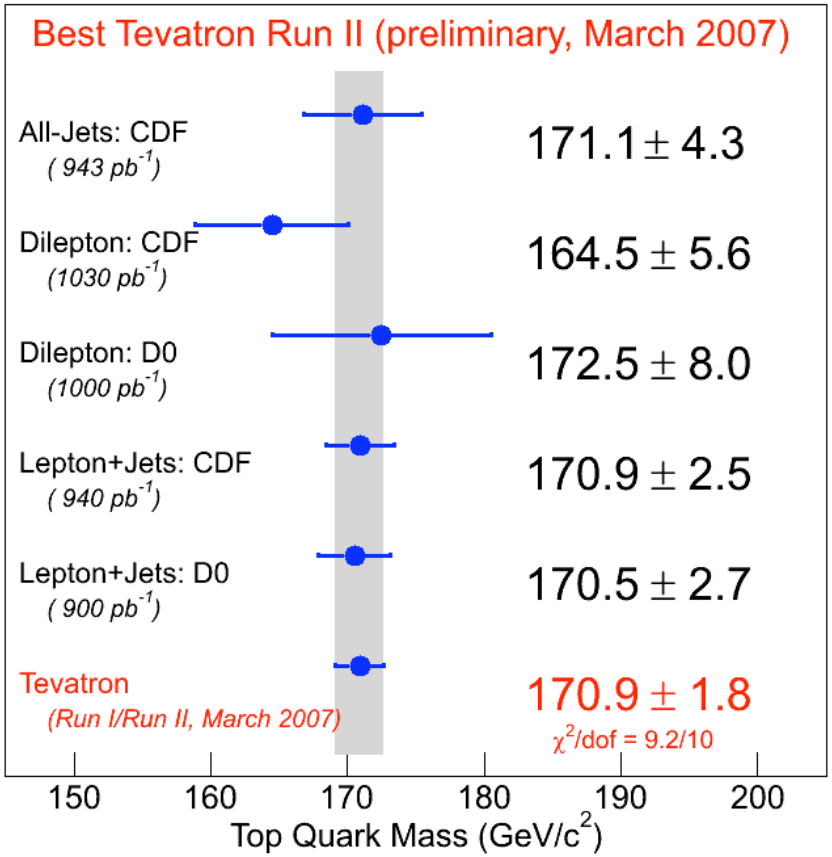
- Top physics only studied at the Tevatron
- Probing top properties with unprecedented precision
- Some examples with $1fb^{-1}$…

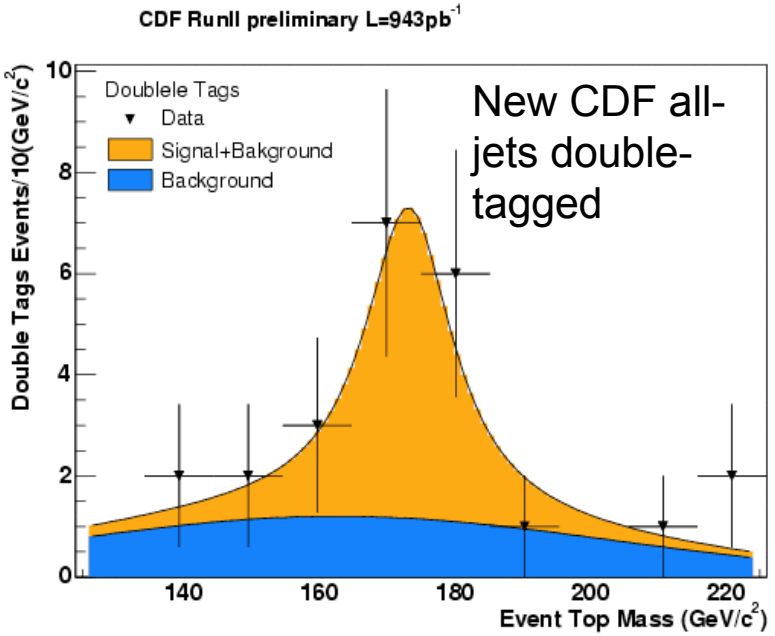






Top mass



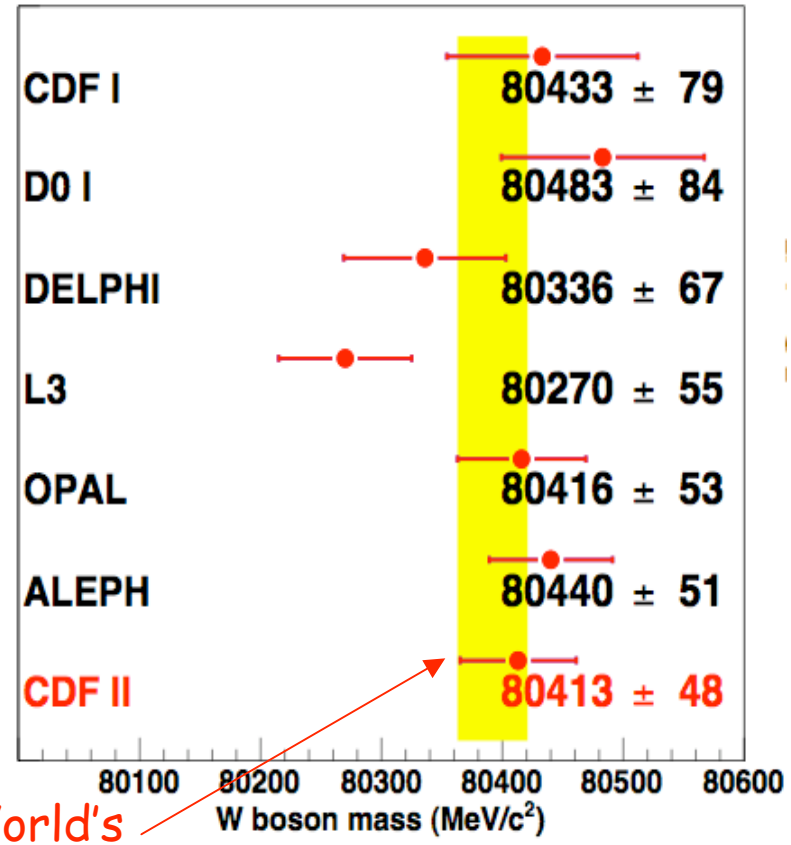


$M_{top} = 170.9 \pm 1.1(stat.) \pm 1.1(JES) \pm 1.0(syst.)\,GeV/c^2$

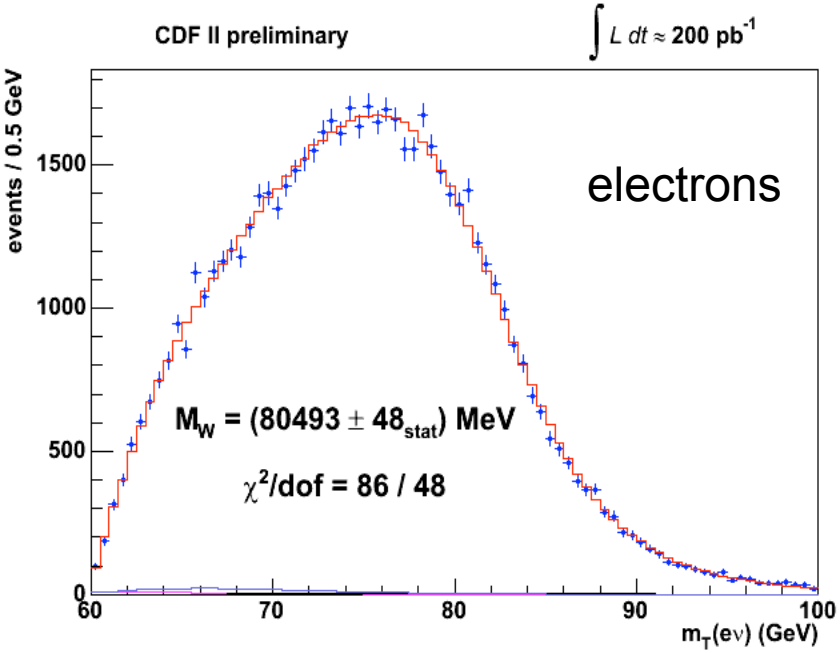
40% improvement in one year!

- CDF added the all-hadronic decay mode with in-situ JES uncertainty (20% overall improvement -> will compete with lepton+jets channel)
- Tevatron can reach 1 GeV uncertainty (similar to LHC goal) using the full Run II dataset

W mass



World's best



New world average: 80398 ± 25 MeV/c^2
(previous average: 80392 ± 29 MeV/c^2)

- Systematic uncertainties dominated by statistics of calibration data:
  - Looking forward to δM_W < 25 MeV from 1.5fb^{-1} of CDF data

- Also the most precise measurement of the W width by a single experiment: Γ_W = 2032 ±71 MeV/c^2

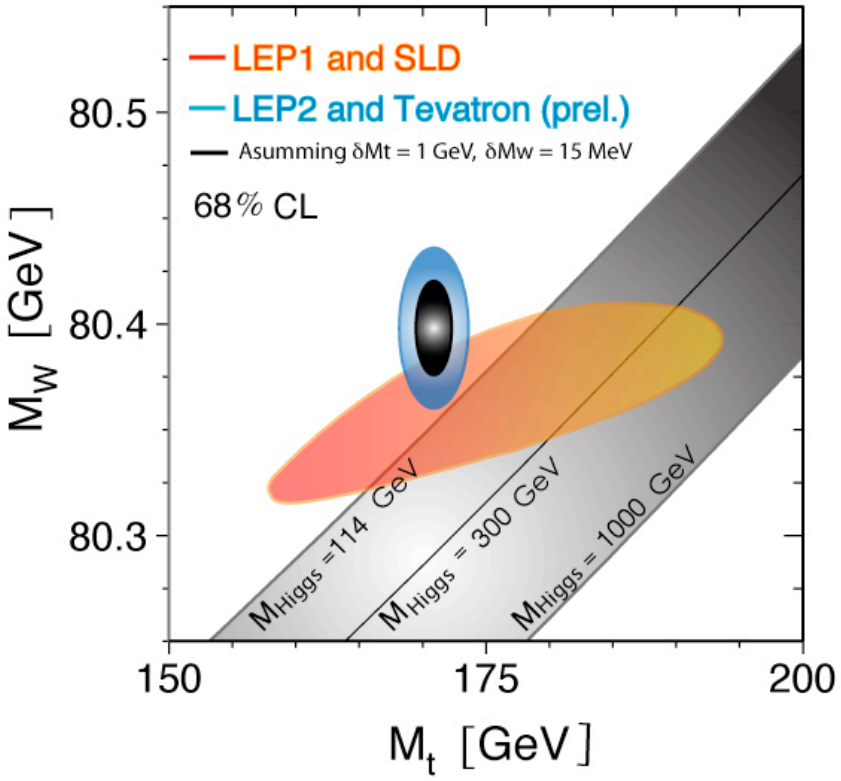
Higgs

- M_{top} and M_W constraint on Higgs mass is important:
  - Tevatron measurements hint the existence of a low mass Higgs

- Current indirect limits on Higgs
  - $M_{Higgs} = 76\ ^{+33}_{-24}$ GeV
  - $M_{Higgs} < 144$ GeV

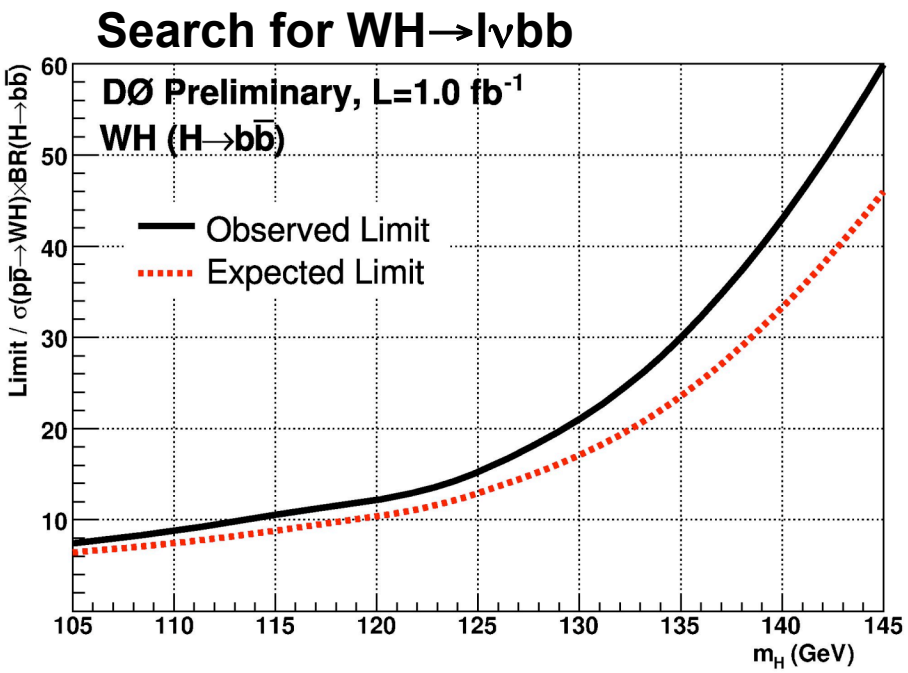
- Precision of δM_{top} 2 GeV, δM_W = 25 MeV translates in $\delta M_{Higgs}/M_{Higgs}$ = 37%

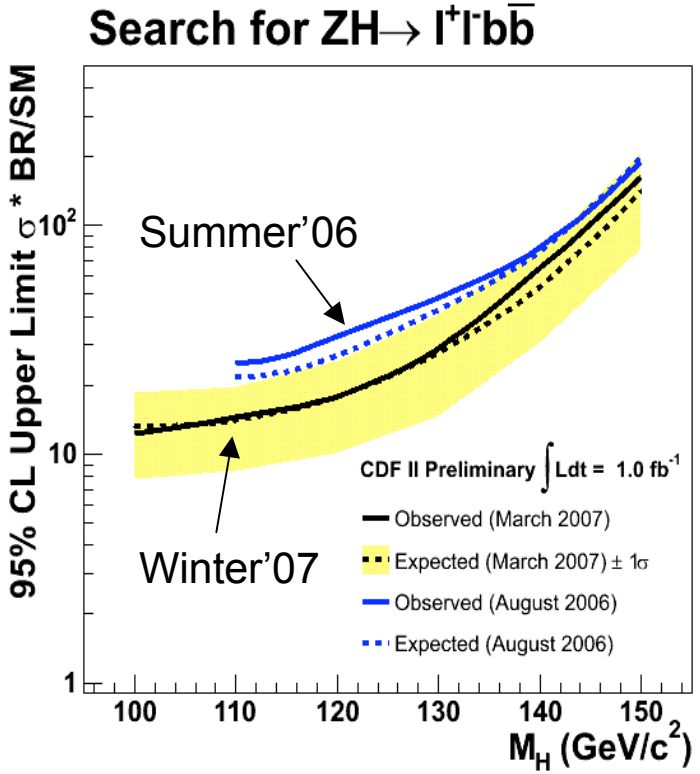
- Expected Tevatron precision could constrain it to ~25% using the full Run II dataset



- Tevatron great place to find a Higgs in the expected range!

Direct Higgs searches



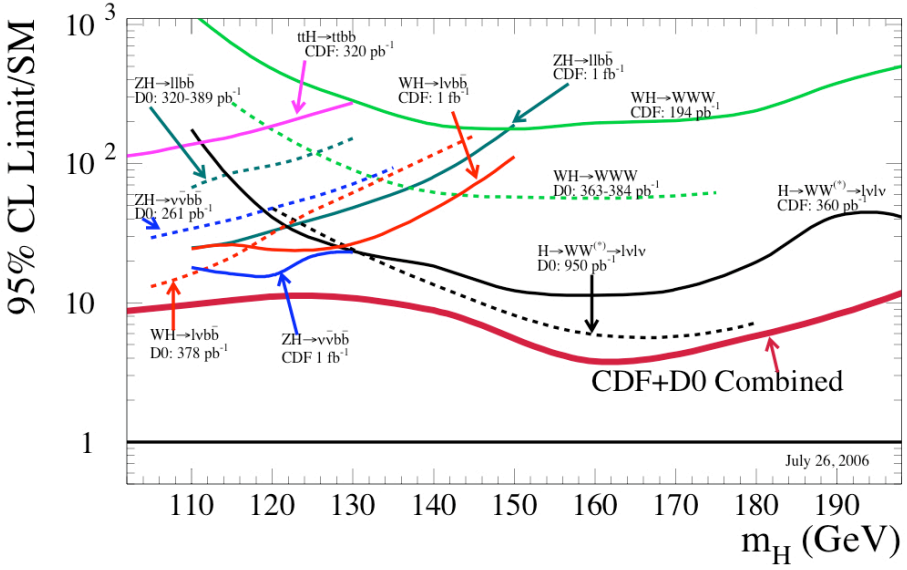


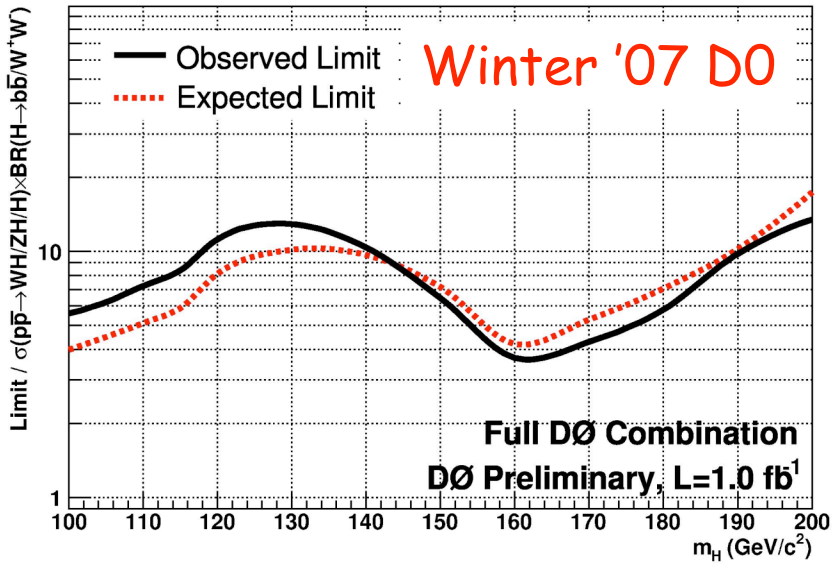
- Improvements in the acceptance, better b-tagging and jet resolution algorithms, analysis techniques, exploiting better understanding of the backgrounds
  - ZH: With the same luminosity in 6 months the limit improved by a factor of ~50%
  - WH: A factor of 2 better limit than previous WH analysis with 1fb^{-1}

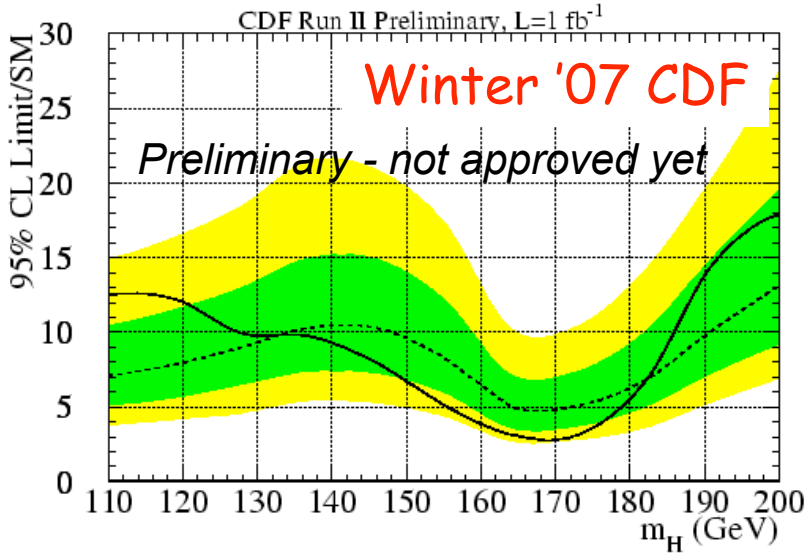
Higgs combined limits

- D0 and CDF improved analysis make the experiment results comparable to previous Tevatron combination

Summer'06 Tevatron





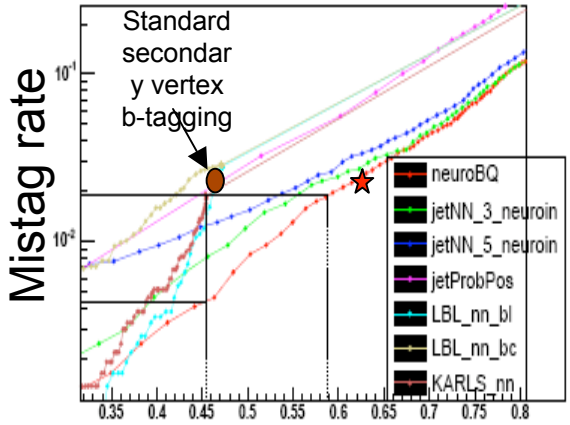


- Both experiments show similar sensitivities across M_{Higgs}

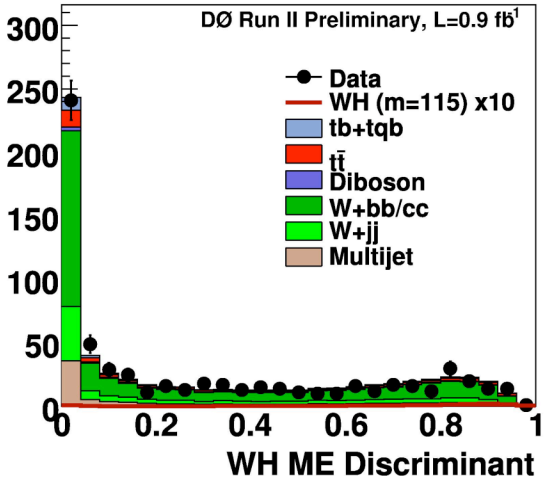
Prospects on Higgs searches

- Still room for improvement…
- Both collaborations working on improving acceptance, better tools and analysis techniques

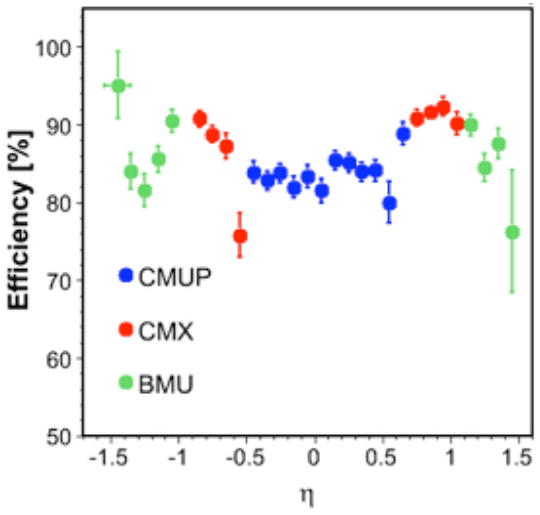
Improved b-tagging



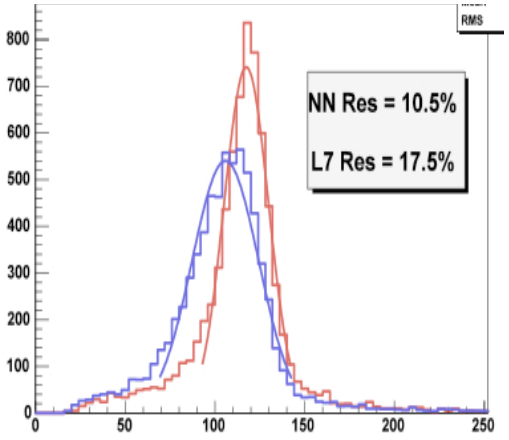
Advanced techniques



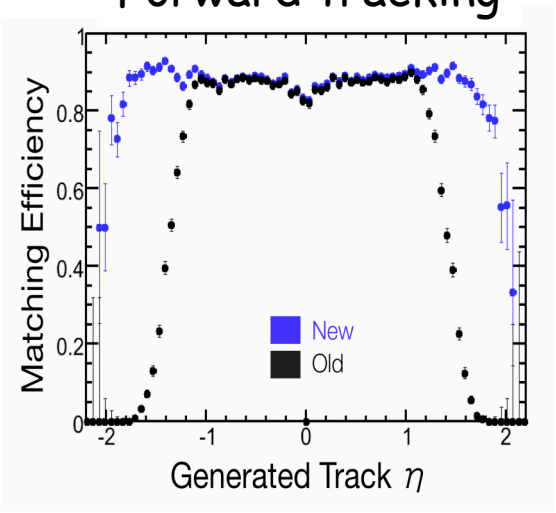
Forward muons



Improved Jet E resolution



Forward tracking



Conclusions

- D0 and CDF are in good shape:
  - Detector performance is healthy
  - Running at high luminosity
  - Collecting high quality data at high rate

- The collider physics program is rich and ground-breaking:
  - Important results came out of the Tevatron last year
  - Impressive amount of publications from both experiments
  - Expect to continue this trend until the end of Run II